Advances in surgery

Weder, W

Abstract: In the last decade, technological advances, new staging tools, better understanding the role of surgery within multimodal treatment concepts in advanced stages and progress in the functional assessment of surgical candidates improved the quality of surgery in the management of patients with lung cancer. Lung resection with video-assisted thoracoscopic access gained wide acceptance, the indication for lobectomy or sublobar resection in early stages was applied based on new data and selection for multimodal treatment in stage III is better understood based on the data. a major impact on the outcome of patients with lung cancer has the treatment in specialized high-volume centers.

DOI: https://doi.org/10.1093/annonc/mds364

symposium article

Annals of Oncology 23 (Supplement 10): x43–x45, 2012
doi:10.1093/annonc/mds364

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W. Weder

Division of Thoracic Surgery, University Hospital of Zurich, Zurich, Switzerland

In the last decade, technological advances, new staging tools, better understanding the role of surgery within multimodal treatment concepts in advanced stages and progress in the functional assessment of surgical candidates improved the quality of surgery in the management of patients with lung cancer. Lung resection with video-assisted thoracoscopic access gained wide acceptance, the indication for lobectomy or sublobar resection in early stages was applied based on new data and selection for multimodal treatment in stage III is better understood based on the data. A major impact on the outcome of patients with lung cancer has the treatment in specialized high-volume centers.
Key words: lung cancer, segmentectomy, specialized thoracic surgical centers, surgery for advanced stages, video-assisted thoracic surgery

Surgery alone or in combination with chemotherapy or radiotherapy is the cornerstone of lung cancer treatment. Surgery remains the only or at least most reliable prospect for cure. Several goals have to be achieved to justify surgery in a patient with lung cancer. The procedure should result in a complete resection, the patient should not only survive the procedure, but also morbidity must be kept as low as possible and a good quality of life should be maintained. These principles are known since decades; however, more knowledge generated from clinical trials, better physiologic understanding, technological advances and other aspects have clearly improved the quality of surgical treatment over the last decade. Furthermore, modern imaging methods including positron emission tomography—computed tomography, computed tomography (CT) and magnetic resonance imaging and better staging including tissue confirmation by endobronchial ultrasound and mediastinoscopy allow a precise clinical Tumour–Node–Metastasis staging which is the basis for treatment planning and defines the extent as well as the approach of surgical resection. There is not a single breakthrough technique developed in the past 10 years which has revolutionized surgical treatment, but many details have been improved and the whole spectrum of available new techniques is implemented in many centers. The higher complexity of lung cancer treatment and its need for an individualized medicine has resulted in a formation of specialized lung cancer treatment centers which may allow treatment at the highest possible standards.

minimal invasive lobectomies by video-assisted thoracoscopic surgery

Minimal invasive lobectomies by video-assisted thoracoscopic surgery (VATS) were introduced 20 years ago. At that time, the procedure was performed by few surgeons only and it was debated if VATS resection for lung cancer is an adequate cancer operation. It was questioned if completeness of resection is secured and if mediastinal lymphadenectomy is possible using a minimal invasive approach. Over time more than 20 comparative studies, two of them were randomized, could prove that patients with stage I and II lung cancer treated surgically without a thoracotomy but by VATS had lower local recurrences and a better 5-year survival. A systematic review by Yan et al. [1] summarizes the VATS studies. The excellent cosmetic result of the small incisions and the rapid recovery of the patient after surgery were demonstrated in multiple studies, despite there were conflicting results from others showing equal outcomes in terms of air leaks, atrial fibrillation and bleeding. Once again, these studies showed that the outcome is dependent on consistent quality of surgery and the patient selection. Due to the fast recovery of the patient after surgery and the lesser trauma of surgery, it was demonstrated by Peterson [2] that adjuvant chemotherapy was less delayed, less reduced in dosage and more received >75% of the planned dosage. In the last 10 years, VATS lobectomy became the treatment of choice for patients with lung cancer in stage I and II by many, especially younger surgeons. In some specialized thoracic surgical centers, up to 70% of the patients are resected for lung cancer by VATS. In the last few years, robotic-assisted lobectomy using the 'DaVinci' system was explored in some institutions [3] and its feasibility has been demonstrated. However, until now it has not been shown that robotic-assisted surgery has a major advantage over VATS, mainly due to the fact that some instruments and especially staplers are not yet available in robotic surgery but necessary for a save lobectomy.

lobectomy versus sublobar resection

The question if a lobectomy is necessary for an adequate lung cancer resection in all patients or if a *sublobar resection*

*Correspondence to: W. Weder, Division of Thoracic Surgery, University Hospital of Zurich, Raemistrasse 100, 8091 Zurich, Switzerland. Tel: +41-44-255-8801; Fax: +41-44-255-5096; E-mail: walter.weder@usz.ch

(segmentectomy or wedge resection) can be applied in smaller tumors with at least equally good long-term survival has been addressed also >20 years ago. In a landmark study, the former North American lung cancer study group performed a randomized trial of stage I patients comparing lobectomy with more limited segmental or wedge resection [4]. The results showed that patients treated by lobectomy had statistically a lower local recurrence rate and a trend to better 5-year survival without reaching the statistical significance. This let to the conclusion that lobectomy is treatment of choice for T1 and T2 tumors. However, in this study, tumors up to 3 cm and nonanatomical wedge resections have been included. The role of anatomic segmentectomy for peripheral T1, N0 tumors was studied extensively in multiple case series and small randomized trials mainly in Japan. Several studies showed that T1 tumors of <2 cm in diameter located in the periphery of the lobe and resected by a segmentectomy achieve a 5-year survival rates of 85%–90% [5]. With the implementation of screening programs by CT and/or the liberal use of CT scans for several indications, more small cancers are detected. With the correct indication, segmentectomy became its clear role in lung cancer treatment and lung sparing procedures are applied, whenever possible and indicated.

surgery for advanced stages

Surgery for advanced stages within a multidisciplinary concept has made progress over the last years due to better staging and hence patient selection, safer surgery and a whole spectrum of surgical techniques such as sleeve resections [6]. This allowed achieving long-term survivors even in these advanced cases. Stage III includes a large variety of clinical situations from chest wall invasion together with intralobar lymph node metastasis to any size of a lung cancer in combination with mediastinal lymph node involvement (N2/N3). Furthermore, the prognosis of patients with lymph node metastasis depends largely on the extent of the disease, which may range from micro-metastasis occasionally found during surgery to bulky and/or multilevel involvement of the mediastinum or extracapsular infiltration. Not surprisingly, the optimal treatment including the role of surgery for stage IIIA (N2) and stage IIIB (T4/N3) nonsmall-cell lung cancer is discussed controversially. Adequate analysis of the clinical stage is the key to select the best treatment. In general, patients benefit from surgery, when a radical resection can be achieved with a low morbidity and mortality. A multidisciplinary approach is indicated in most patients, which present with stage III disease at diagnosis. Preferentially, patients should be treated according to the study protocols whenever they are available. Radical surgery including chest wall resection may result in a 5-year survival rate of up to 50% in T3N1 disease. Adjuvant chemotherapy is recommended and radiotherapy is reserved for cases with unclear resection margins. Clinical trials of preoperatively proven N2 patients could show a better outcome when down-staging is achieved after neoadjuvant chemo- or chemoradiotherapy before surgery. The patients who may need pneumonectomy should be selected with caution because some centers experience a high perioperative mortality rate. If unforeseen N2 disease is found during surgery, an adjuvant therapy is recommended. Patients with T4 tumors (infiltration of great vessels, trachea, esophagus, vertebral bodies, etc.) show an increasing 5-year survival from 15% to 35% after radical resection with acceptable perioperative mortality if treated in experienced centers. In stage III nonsmall-cell lung cancer, surgery should be performed within a multimodality approach. Surgery should be recommended when resection is radical, including systematic lymph node dissection and mortality and morbidity are low.

the role of specialized thoracic surgical centers

Specialized thoracic surgeons dedicated to the thoracic oncology field and attached to a *specialized thoracic surgical center* working closely together with other disciplines have given a major impact on short-term outcome and also in long-term survival of patients with lung cancer. Multiple studies have shown the correlation between the higher volume of treated cases by a surgeon and by a hospital and a lower surgical mortality. The SEER Medicare database has evaluated more than 2000 patients treated in 76 hospitals between 1985 and 1996. The 30-day mortality in low-volume centers (less than eight procedures per year) was 6% and in high-volume centers (>67 procedures per year) it was 3%. Even more impressively are the results from national registry of lung cancer in Japan where 11 664 cases of lung cancer surgery were analyzed with a thirty 30-day mortality rate of as low as 0.4% [7]. In Germany, the hospital mortality in 2008 was 7% in low-volume centers (<15 resections per year) and 2.4% in high-volume centers (>180 resections per year). Furthermore, it has been demonstrated that long-term outcome is also clearly different for patients treated by a general surgeon versus a specialized thoracic surgeon since 5-year survival is 7% higher in stage I and II and 6% in stage III when treated by a thoracic surgeon [8]. Bach et al. [9] demonstrate a long-term survival benefit in surgically treated patients with lung cancer based on the number of cases treated in the hospital. It was not explained by surgical mortality alone rather than patient selection and over all treatment. It is most likely that the treatment of a patient with lung cancer in a specialized, high-volume center which has all disciplines has one of the most relevant impacts in overall survival of the patient.

disclosure

The author has declared no conflicts of interest.

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